Future Operations Support Services for Digital Operations Transformation

Carolina Castanheira Pereira Fernandes

Abstract—The problem between Over-the-Top (OTT) and Communication Services Provider (CSP), namely for multimedia streaming services, is not new and has been a topic much discussed in the TM Forum. At time of writing, a technical solution that would benefit both parties has not yet been presented. With the existing model (no integration), both OTTs and CSPs are dissatisfied. Having this concern in mind, a Design Science Research Methodology (DSRM) was used to guide this work, a proposal for a technical solution that can be beneficial to both parties and can potentially solve the existing conflicts. The solution presents the design of Business Processes showing how to integrate the OTT platforms in CSP Operations. Some hypothetical, but close to reality, scenarios were defined in order to show how the model could be applied. The design of the models incorporates information and suggestions collected from national CSPs. To evaluate the accuracy of the methodology, a set of interviews were conducted with industry experts, who evaluated each model of the solution. A set of surveys from users of these types of services was also conducted, in order to understand their opinion about the ideas used in the construction of the model.

Index Terms—Over-the-Top (OTT), Communication Services Provider (CSP), TM Forum, Design Science Research Methodology (DSRM), Business Processes.

1 Introduction

In the last few decades, the telecommunications industry has undergone enormous changes. In the past, operators were in full control of the few services provided (Telephony and Connectivity), technically managing their fixed-line and mobile radio communications infrastructures, basing their business model on long-term infrastructure investments that were financed through usage-based subscriptions and connection commissions (leased lines). However, the changes that this industry has undergone after deregulation in all countries, due to direct competition and from services provided over the Internet offered by "unsuspected" players, have jeopardized their traditional business models, therefore bringing huge challenges and even threats to their survival [1]. It was mandatory to react, as data consumption and competitiveness grew. In truth, these Communication Services Providers (CSPs), are evolved "Telco" companies that are investing enormously in their Business Support Systems (BSS) and Operations Support Systems (OSS) as they try to handle the lack of automation, redundant operations and inflexibility so that they can thrive in this new digital service future [2].

In order to be prepared to offer their services with much more flexibility and customization power, future Support Services (SS) need to be designed so that they can replace the traditional silos between different OSS/BSS processes with a solid architecture that can support the changes in digital operations and deliver orchestration and autonomic principles for Fulfillment and Assurance areas of those Support Services [3], [4].

This necessity was a result of the appearance of the so called Over-the-Top (OTT) providers, which, due to the proliferation of IP-based networks, made it easier for decoupling of application and network layers, enabling those OTT providers to deliver their services, contents and applications directly to end consumers, competing against similar services provided by the Telcos.

Since OTTs deliver their services over the Internet, they "make use" of the Telcos infrastructures without any type of costs or regulation associated to them. Telcos are therefore seen as mere "bitpipe providers" because they do not "know" or control the type of contents and applications from the Internet, that their networks carry to their own customers. The increasing amount of data that passes through Telcos channels, which, ultimately, tends to congest their networks, compelled them to build and upgrade their networks at a faster pace, which in turn brought even more OTT traffic [5].

The traditional Telcos, although trying to compete with OTTs by widening their Service Portfolio, are still deeply worried because these OTT companies offer services that are extremely similar to theirs, and pose a credible and quantifiable threat to their revenues. To be able to turn the tables, Telcos have begun to realize that the time has come to invest strongly and increasingly in new applications, process automation, networks and customer care in order to differentiate them from competition (other Telcos, as well as OTTs). However, data and mobile usage keeps growing, and network technologies are still in dire need to some kind of modernization [1].

From the OTTs side, not all is easy, as they also face a few challenges that must be overcome. OTTs offer their services over the Internet (best-effort networking) that usually pro-

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vides just enough quality for casual communications, and so, even in a "Net Neutrality" ecosystem, they still cannot guarantee adequate quality for professional communications such as in e-Health, or pre- and after- sales support, important features which Telcos still offer with pronounced value and worth.

In this basis, a structured transformation of organization, processes, applications, data and network technologies is an essential factor for success.

In our study the focus is on multimedia streaming services, that are a strong favorite for the "on demand" experience and the main challenge to CSPs. This research work, takes as foundation the developments being made by the TM Forum [1], that specifies a set the best practices and standards and has provides a Framework Model that is acknowledged, well known, as well as contributed by the entire telecommunications industry and can be seen as the *de facto* standard [1].

Currently, the TM Forum is deliberating on how to give an answer and find a balanced and well-adjusted solution to these setbacks that are directly affecting both CSPs and OTTs.

The journey has just begun for CSPs and OTTs: they have to work together and reach an agreement that will be beneficial for both parties, to meet the challenges that technology development brings. In essence, the problem is that current BSS/OSS of CSPs do not include a joint model with external OTT providers and their Service Platforms. To find a solution, it is necessary a digital operations transformations to provide orchestration and automation principles for the Fulfillment and Assurance areas related with services offered by OTT, but in partnership with the CSP.

The purpose of this work is to present an architectural vision on the design of a future SS technical integration model with OTT providers, which allows to combine these partners and their products into the BSS/OSS processes of CSPs.

The remaining of this document is structured as follows: Section 2 describes the methodology that was followed, Section 3 provides a theoretical background, containing a clarification of the most important concepts; Section 4 describes some works regarding the scope of this research; Section 5 describes the artifact and the elements that support it; Section 6 describes the demonstration scenarios; Section 7 assesses the solution to the identified problem through interviews and surveys, and Section 8 draws conclusions on the research work and suggests future work.

2 Research Methodology

As a problem-solving model, Design Science Research Methodology (DSRM) recapitulates the creation and assessment of a ground-breaking Information Technology (IT) "design artifact", in order to attend to an important organizational problem. Constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices) and instantiations (implemented and prototype systems) are considered design artifacts. As a result of the feedback offered by assessment phases, this iterative approach aims to enhance both the quality and process of the design artifact, looking for its veracity (justified theory) and utility (effective artifacts) and evaluated when it comes to its practical implications [6]. This methodology proposed by Peffers *et al.* [7] for the production and presentation of Design Science Research (DSR) in Information System (IS), is made up of six phases: a): Problem identification and motivation, describing and identify the research issue, justifying the solution's importance; b): Defining the solution's goals, deriving the goals from the problem definition, taking into consideration what is possible and feasible; c): Design and development of the research artifact, once determined its desired functionality and architecture; d): Demonstration, to show how to use the artifact, which can be accomplished through experimentation, simulation, case study, proof or other applicable activity; e): Evaluation, by observing and assessing how well the artifact supports a solution to the problem; and, f): Communication of the problem and its value, the artifact, its functionality and originality, the thoroughness of its design and its effectiveness to relevant audiences.

3 Fundamental Concepts

This section, presents and discusses the main concepts and technologies, related and addressed in this work.

3.1 OTTs and CSPs

OTTs are providers of services directly to their end users, over the Internet, typically not subject to both local regulations and network infrastructure costs.

With the emergence of OTT, there was a turn from traditional telephony to OTT Communications and a replacemnent of Short Message Service (SMS) by OTT applications such as WhatsApp. Traditional Broadcast services (radio, television, news, audio and video transmission) are also being replaced by multimedia streaming applications such as Netflix, HBO, Spotify, FOX Play, Mubi and Qobuz, are providers of media streaming services (music and vide, among others[2]. In the United States of America, Netflix even managed to overcome a major cable provider and, nowadays, young adults watch less linear TV, preferring Internet-based streaming services [8].

It is therefore obvious that Telcos are facing a massive challenge in their businesses, having to react quickly in order to keep up with today's technological advances and this competition to their traditional core business.

The business models of OTT Services rely deeply on competition, the market, and customer segmentation, and based upon the following revenue sources [9], [10]: a): Subscription: Customers pay a periodical fee to benefit from the service; b): Usage/Transaction: by metering the usage of for each transaction; c): Advertisement: where Suppliers sell different advertisements based on costumers preferences or habits; d): Donation: in platforms (such as Wikipedia)

1. www.tmforum.org

2. www.whatsapp.com, www.netflix.com/pt/, hboportugal.com, www.spotify.com/pt/, www.foxplay.pt, mubi.com, www.qobuz.com

funded by donations (Crowd Funding); e): Freemium: where customers may benefit freely from the basic features, but have to pay to access premium or convenience features; and, f): Monetization: where Suppliers pay users for disclosing private information.

As described in [10] it is possible to identify eight strategic options for a Telco when dealing with OTT players:

The Zero Option: No action is taken against OTTs. OTT services are seen as a disadvantage to flate-rate contracts, but are seen as beneficial to the "pay as you use" contract models;

The Defense Strategy: This strategy has two approaches Data Capping and Network Slicing;

The Attack Strategy: This strategy normally leads to Blocking or throttling traffic or to Emulate OTT Services;

The Cooperative Strategy: Three approaches can be considered: Product Partnership, Sponsored Data Approach, Acquisition of OTTs.

A "Do nothing" strategy will not work and result in Telcos becoming just "bit-pipe" providers with strong effects on employment and profitability. Many "attack strategies" are blocked by current regulations in may countries. "Cooperation strategies" are good short term strategies, but may not differentiate much in competition if many Telcos follow such approach. Therefore, "defense strategies" with data capping in the short term and network slicing in the medium term may be the recommendable way for most.

For Telcos preferring partnership models, the cooperation can enable and simplify the creation of new revenues if they sell premium OTT services and agree on revenue sharing.

This is an important topic in our analysis related with the principle of "Net Neutrality", which is that any Internet Service Provider (ISP)/CSP must treat all traffic in their networks likewise (i.e., not discriminating or charging differently) regardless of its origin, destination or content.

Nevertheless, though rarely reported, it is common practice for Telcos to "regulate" the bandwidth in their networks in the case of extreme volumes of data transfer from OTTs, e.g., streaming of Ultra High Definition (UHD) multimedia contents, by prioritizing their own traffic or limiting (throttling) interconnect Internet traffic, reducing therefore the "quality" of OTT services.

A strategy based in collaboration and mutual cooperation is therefore the approach considered for the solution in this work, in order to benefit both parties.

3.2 OSS/BSS

OSS and BSS are used to support all the telecommunication services of a CSP [11].

BSS corresponds to customer-oriented business operation processes, such as "Order Management" or "Customer Management".

OSS correspond to infrastructure-oriented operation (Networks, Services Platforms and support functions) from "service Fulfillment" processes for provisioning and activation (including network configuration), and "service Assurance" processes (including monitoring and problem management). OSS are designed to help reduce the overall operating costs and improve efficiency, through automation of the key workflows of the operations.

3.3 TM Forum's Frameworx and the Enhanced Telecom Operations Map (eTOM) standard

The TM Forum is a neutral, non-profit member organization that promotes collaboration and collective problem-solving in order to maximize the success of (tele)communications- and digital services providers and their supplier ecosystem [12].

The TM Forum community was responsible for creating the **Frameworx** [13], a suite of best practices and standards that enable a service-oriented, highly automated and efficient approach to business operations.

Frameworx delivers standardized Business Metrics that the industry has embraced and allows for benchmarking, as well as an assembly of interfaces and Open Application Program Interfaces (APIs) that allow integration across systems and platforms. Companies also benefit from Frameworx since it also helps implement and use top standard and management processes to guarantee ongoing conformance [13].

The TM Forum maintains industry standards for describing system functionality, processes and exchange of data under the Frameworx suite key components, such as the **Business Process Framework (eTOM)** [14], [15], the **Application Framework (TAM)** [16] and **Information Framework (SID)** [17], together with the **Integration Framework**, **Business Metrics** [18] and **Best Practices**.

eTOM designates the interaction of the processes between different stakeholders in the telecommunications value chain and also contains cross-functional views that show how process components span horizontally across a company, allowing for superior detail in decoding the interaction process throughout the organization. According to the eTOM model, all company business processes are divided into three vertical functional groups in its first level of specification: Strategy, Infrastructure & Product; Operational Management and Enterprise Management [19]:

The Shared Information/Data Model (SID) delivers a reference model for all the information that is needed to implement the Business Process Framework processes, reducing system and services integration complexity, development and design by offering an off-the-shelf information model that can be quickly adopted by all parties [17].

The Telecom Application Map (TAM) offers a commonsense grouping of applications, defining what functionality is offered by each application. It also allows for a mutual language between communities who specify, acquire, design, and sell OSS and OSS solutions, making it possible to understand each other's viewpoints [13].

The Integration Framework is a set of criteria that supports the interoperability in-between applications outlined in TAM via TM Forum interfaces. The interfaces are defined in terms of the SID's entities/attributes, and the necessities for the interfaces from a business process perspective, which comes from eTOM.

Best Practices provide useful and practical tools that balance Frameworx and help to improve end-to-end services management across complex, multi-partner environments.

For this study the focus was on eTOM, which is used to describe and position OSS and BSS systems and processes in relation to one another.

3.4 Modeling Languages and Tools

The modeling languages and tools that were used for the design of the proposed solution, were Business Process Model and Notation (BPMN), Unified Modelling Language (UML), Archimate and Flowchart.

BPMN provides a graphical notation for business process specification, based on a flowcharting technique very similar to the activity diagrams of the UML [20]. Its main objective is to support business process management by providing a notation understandable by all business stakeholders while also being able to represent complex process semantics.

UML is a modeling language for software engineering that provides a standard way to visualize the design of a system.

Archimate is an enterprise architecture modeling language and a standard of the Object Management Group (OMG) [21]. ArchiMate distinguishes itself from other modeling languages such as UML and BPMN by its enterprise modeling scope. Thus, Archimate not only supports the description of business processes but also organizational structures, information flows and IT systems and infrastructures.

A Flowchart is a diagram which represents the sequence of actions in a particular process or activity.

4 Related Work

In this section, the works "Next Generation Telco Architecture", by Deloitte and the "Future Operation Support Services" by Huawei and Orange are presented and discussed.

4.1 "Next Generation Telco Architecture"

An architecture that can answer to the future of the Telco business needs has been studied, to a great extent, by Lorenzo Cerulli and other authors. This theoretical Telco architecture is founded on an "API Fabric" model that depends on microservices, "softwarized" infrastructures and big data abilities that determine the features of the current IT architectures of the Telco industry [22]

The author goes on to say that the continuing digital transformations are not capable of supporting today's IT architectures because they are "intricate, inflexible and retain reduced amounts of automation since their procedures result from a large number of merges and acquisitions". The author also defends that operators should embrace the IT reference model developed by OTTs in order to solve current IT architecture errors, therefore achieving an architecture founded on the use of microservices, APIs, Big Data and cloud platforms, i.e., the "BSS/OSS API Fabric Architecture".

OSS/BSS are distributed into smaller components within this architecture, according to the microservices paradigm or substituted by Software as a Service (SaaS) solutions. Each component has its functionality which is stable and reusable. Breaking down systems into smaller services allows the same technical features to be reused in diverse business processes. Microservices and the SaaS components interact through APIs. Business processes are achieved through a choreography model, where interactions are directly managed by microservices. Accordingly, the communication layer is implemented using a simple "message bus".

The author poits out that Data will be increasingly consolidated into a centrally managed Information Architecture (IA) in the Data Tier Layer, by means of a mutual and combined information model. The IA is responsible for offering access to information through different functions. Through standard APIs, access to information (offered as a service) will be implemented, which avoids the need to understand low-level data constructions.

Big Data and analytics skills are consolidated into centralized systems when it comes to the Big Data Layer. Analytics will interact with the API Fabric environments, by means of real-time analysis and pattern recognition, therefore prompting the start of optimization workflows. Using big data analysis, Analytics will support developments of the customer experience, enabling pattern recognition and reacting in almost real-time, thus starting the implementation of distinct business processes.

When it comes to the Infrastructure Layer, as so to satisfy business requirements that need rapid and agile deployment, IT infrastructure must grow in order to adopt cloud technologies (such as Infrastructure as a Service (IaaS)).

Lastly, the author concludes that new applications can be developed using typical building blocks thanks to Platform as a Service (PaaS) solutions, with building blocks libraries enriched with reusable components.

4.2 "Future Operation Support Services"

The strategic plan described by Huawei and Orange addresses digital transformation and presents a common architectural vision that points out how to design agile Future OSSs. This OSS defines an architecture framework that provides a common digital platform for network and service administration and is made up of several domains [2], namely: 1): **Cloud/PaaS:** The Future OSS cloud-based platform; 2): **Design Systems:** enabling DevOps and model-driven design; 3): **Support Systems:** linking the Future OSS Design-Time and Run-Time via Dynamic Inventory, Catalogue, Policy Management, and API Management; 4): **Orchestration:** automating and accelerating all actions necessary to provide end-to-end service management for cost effective hybrid Fulfillment and Assurance. Data Collection and Analytics modules within Orchestration extend this support to allow intelligent closed loop operation; 5): **Fulfillment:** providing the link with existing OSS/BSS implementations, turning business requests into solutions; and, 6): **Assurance:** guaranteeing quality of service through dynamic operations and automation of manual, time consuming tasks.

4.3 Discussion

Conceptually similar to the architectures presented in [22] and [2], our model also aims to answer to the future needs of telecommunications business and proposes to function as a platform that integrates another platform/service, that is, the OTT would function as an Operator Service Platform, being integrated in the CSP as any other Service Platform.

Cerulli claims that operators must adopt an architecture based on the use of APIs, microservices and big data. Our model advocates the same principles , considering that the operator's platform interacts with the external Partner platform through APIs.

As each component of the API Fabric model is stable and easy to reuse, our model also aims to include this feature.

The model proposed also aims to demonstrate how to design a swift future OSS based on the eTOM framework, focused on the processes of Fulfilment, Assurance and Billing.

5 Proposed Solution

The third DSRM step, corresponds to the "Design & Development", of the solution to address the research problem.

Based on the analysis of the related work and on the identified research problem, the following objective was established for the proposed solution:

To develop a model that allows service providers to work together, that is, design a model that allows the integration of OTTs service Platforms on CSPs platforms and, thus, benefiting both. In order to obtain a model as accurate as possible, several iterations were performed.

In an initial phase, the theme was validated by two national operators, Vodafone Portugal and NOS Comunicações, and by an OTT, Netflix, in order to establish the potential of the subject and to identify their interest in this great challenge. The opinions were favourable regarding the concept and both operators showed interest in validating the proposed model as soon as finished.

The following sections briefly present the **AS-IS** and **TO-BE** for the service delivery model of the operators, as well as the design (in high-level detail) of some of the key processes.

5.1 AS-IS operators' service distribution model

CSPs provide three types of basic services to their customers: telephone (voice communications), Internet (access) and TV (linear broadcast-type and on-demand). These services are commonly sold together in Product bundles.

Television and telephone services over fixed lines, have signal priority over Internet services and therefore service quality is only guaranteed for telephone and TV.

As mentioned previously, it is through Internet service that OTT providers reach the final customer and, as such, they cannot guarantee service with quality for their products.

Figure 1 illustrates the typical operators' distribution model for the services, which shows for example, that video and music streaming from OTT are conveyed through the Internet channel. As this channel has the lowest priority, the transmission of these services is questionable, and may be of poor quality and even prone to frequent failures.

In an ideal world, the service quality problem would be solved if the Internet service had a priority, at least equal to the other services. However, this is not what happens and, as such, it was necessary to review the current model of CSPs in order to be able to understand which processes could be improved.

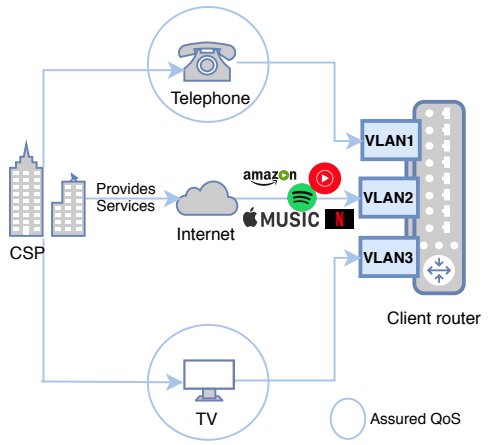


Figure 1. Current operators' distribution model service

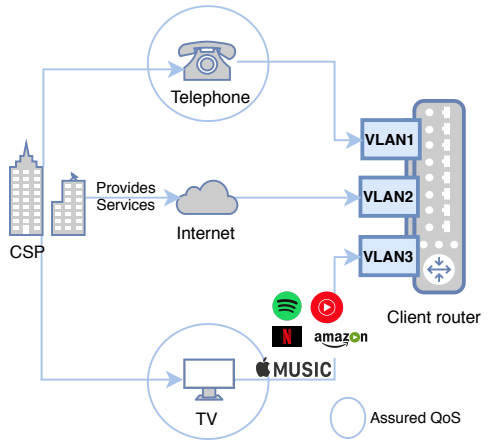


Figure 2. Alternative operators distribution model service

5.2 TO-BE operators' service distribution model

To allow OTTs to distribute their services with guaranteed quality, and at the same time enabling the CSPs to invest further in their infrastructures assured that they will be compensated by ideally "shared" revenues from OTT services, an alternative model for services distribution was designed, illustrated in Fig. 2.

Considering, for simplification, the case of multimedia content distribution, if the OTT services would be treated at the same priority level as the TV service, the service quality problem would be eliminated as the CSP has absolute control over the quality parameters in their access networks. In addition, Internet service overload due to video and music streaming from OTTs would eventually not occur, since these services would be distributed through a resource controlled channel.

5.3 New Models and Processes

In this section we will present the various processes and models developed in order to support the alternative model of a CSP service delivery.

5.3.1 Product definition and provisioning diagram

The development of a flexible data structure for the definition and provisioning of telecommunication products is

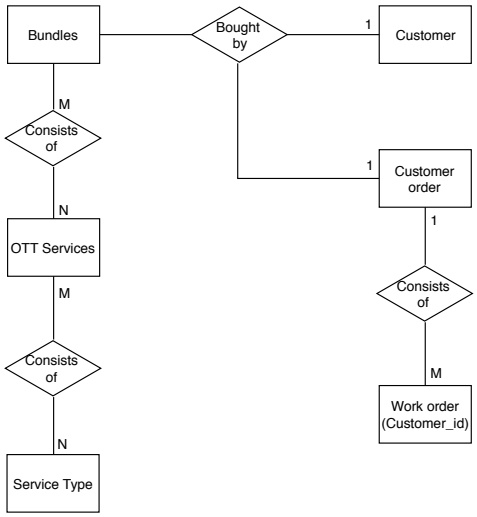


Figure 3. Flexible data structure for product definition and provisioning. Adapted from [1].

based on common approaches of the manufacturing industry [1]. The solution consists of product, service and resource, where, as illustrated in Fig. 3, the product corresponds to service bundles (consists of both technical components and commercial specifications), the service corresponds to OTT services (providing features, which are set independently of their technical achievements) and the resources (the technical achievements of features) corresponds to the Service Type.

The customer buys a product with certain defined functional parameters. The purchase of a product is processed into a Customer Work Order, which is then unbundled into one or more Service Work Orders. These Work Orders have an associated "Customer_id" that identifies the consumer who triggered the Work Order.

5.3.2 Product Viewpoint - Bundles diagram

The product viewpoint presented in Fig. 4 aims to represent the options that the customer has when joining OTT services offered by a CSP.

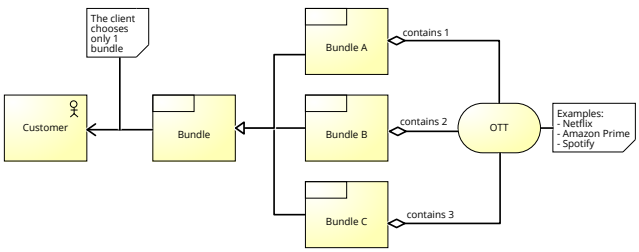


Figure 4. Product Viewpoint

By way of example we define 3 bundles with different content:

- Bundle A, with this bundle the customer has the right to choose one OTT;
- Bundle B, the customer can choose two OTTs;
- Bundle C, allows the customer to choose three OTTs.

For all the bundles there is a list of available OTTs, from which customers can choose the ones they want. This list is defined by the CSP, according to the partnerships agreements between the CSP and the OTTs.

5.3.3 Membership

The process begins when a Party (Individual or Organization) wants to subscribe to a bundle that includes OTTs. The Party is checked in order to determine if it is already a Customer. In the case of being a new Customer of the CSP, a customer file and a "Customer_id" are created. Once the account settings are finalized, it is possible to subscribe to services to be provisioned for each account of the Customer.

5.3.4 Class Diagram

The UML diagram of classes represented in Fig. 5, aims to outline the associations between the several classes, as well as their methods and attributes.

In Portugal there are four main service providers (CSPs): Altice/MEO, NOS, NOWO and Vodafone. These CSPs are represented in the diagram by the class "**CSP**". A **CSP** aggregates multiple customers ("**Customer**" class) which, in turn, have one or more accounts associated to their customer file.

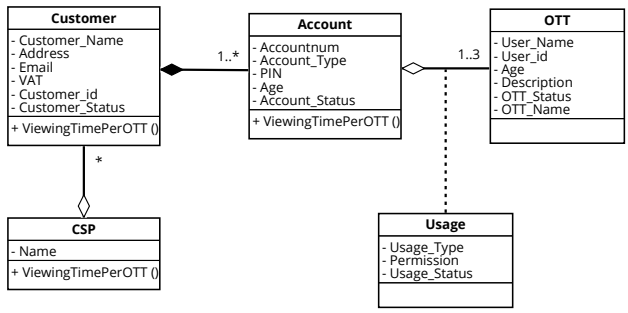


Figure 5. Class Diagram

Each account can be associated to 1, 2 or 3 OTTs. This class has the following attributes:

- An account number ("Accountnum") that allows to uniquely identify the User of each account. For example, a customer who has two accounts associated to their file has 2 different "Accountnum";
- A type ("Account_Type") that distinguishes the type of account: child or adult. In the case of a child account, parent content restriction is allowed;
- A PIN code that allows the costumer to block undue access to created account parameters;
- An age ("Age") that enables the service to recommend content that is appropriate for each age group.
- A status ("Account_Status") that allows to know the status of each account, i.e, whether the account is active, blocked due to non-payment or disabled.

The "**Usage**" class represents the relationship between the "**OTT**" and "**Account**" classes, allowing to check the permission that a certain account has for accessing a certain OTT.

The OTT class has attributes such as "OTT_Name", "Description" of OTT and "OTT_Status" that allows to determine the status of OTT account, that is, whether the account is active, blocked for non-payment or disabled.

The "ViewingTimePerOTT" method of the "**Account**", "**Customer** and "**CSP**" classes allows to compute the viewing time per OTT for each account, client and CSP, respectively.

The "**Customer**" class has attributes of "Name", "Address", "email" and "VAT", which are fields that belong to the customer files created when joining one of the bundles.

The diagram in Fig. 5 was designed based on the TM Forum's Information Framework (SID) [17], a reference model for implementing eTOM business processes.

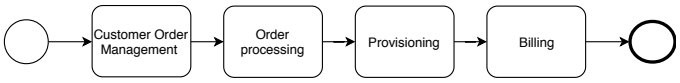


Figure 6. Level 1 - Reference process flow Order-to-Payment, adapted from: [1]

5.4 Reference process flow "Order-to-Payment"

Figure 6 represents a typical sales process at level 1 and Fig. 7 represents a detail process at level 3 of the "Order-to-Payment" process.

The "Order-to-Payment" process is responsible for the commercial processing of a Customer Order, the Provisioning and Activation of the Services and the subsequent Billing of consumed services. From all the designed processes of the developed model, in this paper only the Level 4 processes for "Add Service" (Fig. 8a), "Change Service" (Fig. 8b) and "Remove Service" (Fig. 8c) are illustrated. The complete model is described in [23].

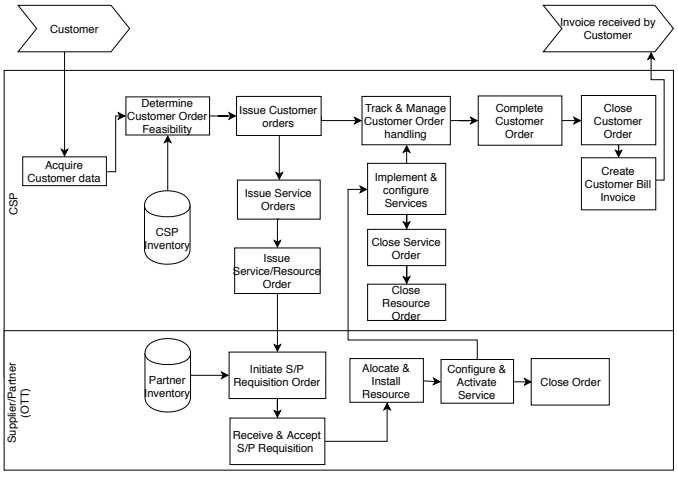


Figure 7. Level 3 - Process elements in Order-to-payment. Adapted from: [24]

5.4.1 Order Processing (Level 4)

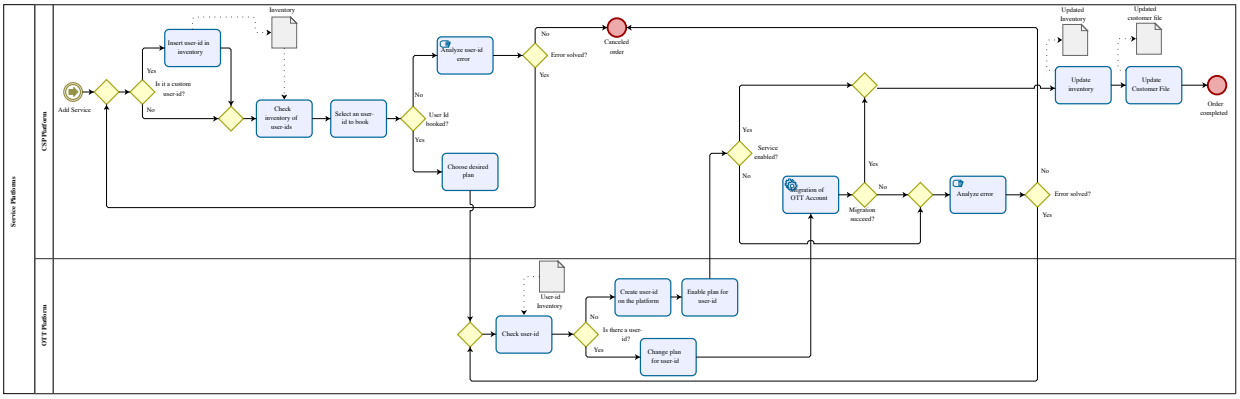
The various types of activities that a Customer can request from the CSP are typically streamlined as Adding, Changing or Terminating services. These activities are therefore implemented as Work Orders of type "Add Service", "Change Service" and "Remove Service".

The "Customer_id" as previously described corresponds to the unique identifier of the Customer on the CSP platform, while the "User_id" is the unique identifier of the User (the Party that uses Products) of each account of the Customer. When a "User_id" is assigned or associated to a customer account, it is associated with the existing "Customer_id".

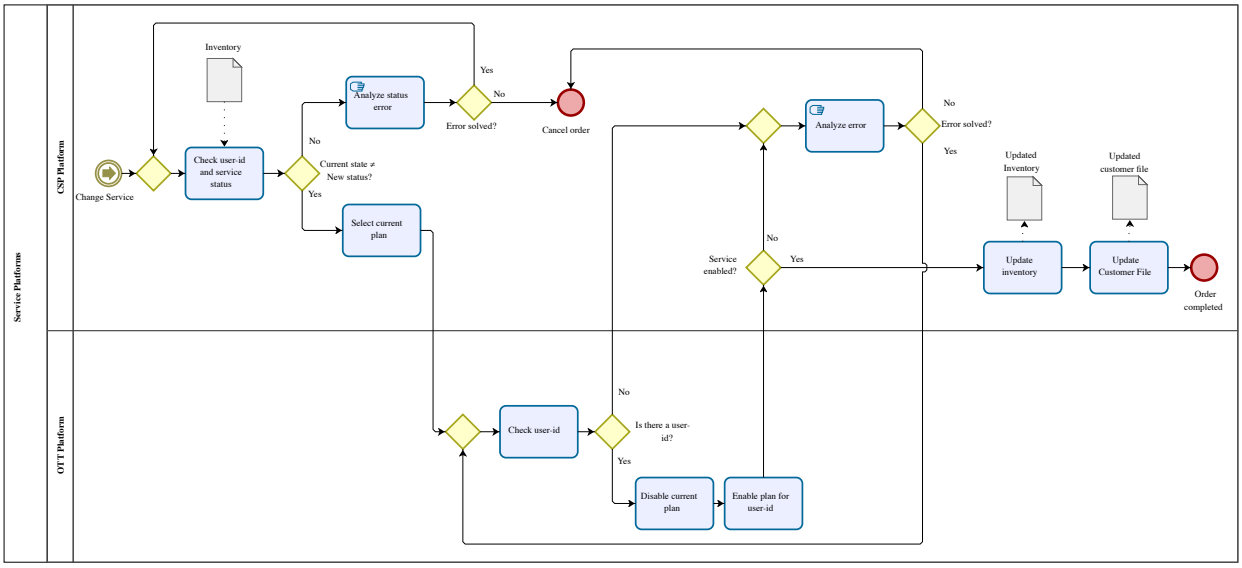
As for the processes design, as illustrated for example in Fig. 8a, it is assumed that a "Customer" already exists (was created) on the CSP platform, that is, the "Customer_id" is already known and was validated for the work order. It is important to take into consideration that the data object represented in these processes as "inventory" corresponds to the CSP Service/Resource Inventory subsystem, which contains all the "User_id"s available for the CSP to assign to their Customers. These "User_id"s are defined and distributed by OTTs to CSPs. The data object represented as "User_id inventory" contains all the OTT "User_id"s, that is, the "User_id"s distributed by the CSPs, as well as the "User_id"s created directly on the OTT platform.

The Customer Work Order process starts when a Customer requests one of the following situations:

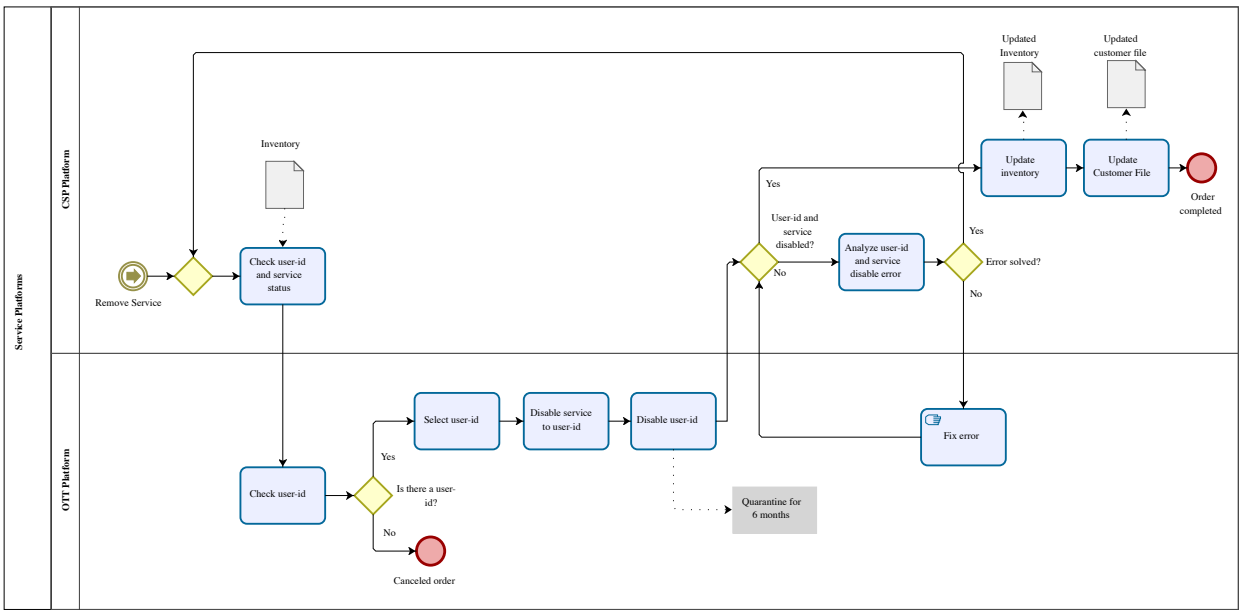
- **Add Service:** When a Customer wants to add a service, an order of type **Add Service** is created (Fig. 8a).
  - The CSP platform checks whether the "User_id" is custom or "stock". A custom "User_id" is a "User_id" previously created directly by the user on the OTT platform or created on the platform of another CSP. This situation occurs, for example, when a customer had previously subscribed services directly of an OTT and wants to migrate the account to the CSP, in order to preserve her/his preferences and usage history.
    If the "User_id" is custom, it is inserted into the inventory, then selected and reserved until the end of the process, when it is marked in the inventory as allocated/active and associated with a "Customer_id". If it will be for a new "User_id" then the inventory is queried to select a free "stock" "User_id", which is then reserved until the end of the process, when it is marked in the inventory as allocated/active and associated with a "Customer_id".
  - After selection of the "User_id", its status in inventory is verified, which, when presented as "reserved", allows to associate it with the desired product/service plan.
  - After selecting the desired plan for the OTT platform, an external order request is triggered to the Partner OTT platform. In the external platform the "User_id" is then checked in the OTT resource inventory. If the "User_id" does not exist, it is then created on the platform and the selected plan for that "User_id" is activated.
  - If the "User_id" exists on the OTT platform, the plan for the service subscribed with the CSP updates the OTT service Plan and triggers an account migration process to the CSP platform. If the migration succeeds, the inventory and the customer file are updated, for that "User_id" and the corresponding plan.



(a) Add Service



(b) Change Service



(c) Remove Service

Figure 8. Service Processes (Level 4)

- **Change Service:** When a Customer wants to change a service, an order of type **Change Service** is created (Fig. 8b).
  - In the CSP platform, the "User_id" and the service state in the inventory are verified, and later confirmed whether the current state is different or not from the new state. If it is different, the new plan is selected and an external order request is triggered to the Partner OTT platform.
  - If the service is activated, the inventory and the customer file are updated and the order is complete.
- **Remove Service:** When a customer wants to unsubscribe to a service, an order of type **Remove** is created (Fig. 8c).
  - In the CSP platform, the "User_id" and state of the service are verified in the inventory, and later on, the same "User_id" is verified on the OTT platform.
  - If this "User_id" already exists on the OTT platform, then the "User_id" is selected and the service associated with it is disabled. As such, the "User_id" is deactivated since there is no service associated to it. This "User_id" is however quarantined for a period of 6 months, to prevent its usage for other customers, and to also allow reactivation for the same customer account.
  - After deactivating the "User_id" in the CSP platform, it is verified that the service and "User_id" are disabled. In case they are disabled, the inventory is updated with the information that this "User_id" is quarantined for 6 months and the client file is also updated, thus completing the work order.

5.5 Usage-to-Payment process

The "Usage-to-payment" process begins with the customer decision to subscribe to a product and ends with the payment for the used product.

Based on the contract, the use of the service requires a usage-based payment, which is related to the volume of data spent, the time of use of the service or number of accesses to the service, depending on what is agreed between the CSPs and the OTTs. The collection and rating of usage data is part of the technology domain. The diagram of Fig. 5 represents the class "Usage" that intends to show how the accounting can be done through the defined attributes (simplified for this example).

6 Demonstration Scenarios

The Demonstration corresponds to step 4 of the DSR method. In order to demonstrate the feasibility of this solution, the following hypothetical scenarios, but close to reality, were defined in order to understand the real application of the designed model. The full description is available in [23].

- A user who was already an OTT customer and intends to migrate the OTT account to his CSP;
- A new CSP customer who intends to contract a Product that include OTT services;
- A user that reduces the level of service, i.e., changes the OTT plan;
- A customer that chooses to cancel the contract and later decides to reactivate the it.

7 Evaluation

The fifth phase of the DSR model corresponds to the evaluation and aims to measure how well an artifact supports a solution to the problem by comparing it with the proposed objective with the observed results of the use of the artifacts in the demonstration. For this purpose, the artifact consistency was evaluated through case studies (the demonstration). The accuracy of the methodology was evaluated through interviews with experts in the industry, and a set of surveys for users of these type of services, in order to understand their opinion about some ideas used in the construction of the model.

7.1 Assessment of the survey results

The survey obtained **304** responses with every region of Portugal represented, as well as various age groups.

From the answers, **179** of the respondents already use at least one OTT service, of which **80%** use the service more than twice a week, and **85%** consider that the quality of transmission is one of the most important features. Regarding the integration of OTT services in the CSPs' platform, **82.6%** considered that it would be interesting to include OTT services in the CSPs offres, and **82.2%** considered as advantageous to access OTT services from their TV. Finally, **75%** agreed that a joint invoicing would be a good option.

7.2 Interviews results

The interviews were carried out with 5 specialists in the areas of Telecommunication, OSS / BSS, Service Platforms, Automation and Product Management. The interviewees belonged to national CSPs (NOS Comunicações and Vodafone Portugal), and positions occupied were of Product Management Director, Director of Service Platforms, Operations Director and Automation Manager.

Each interview lasted approximately 1h30min and a script was used as helper during the interviews, containing specific questions related to the designed processes (and by showing the diagrams of the Model). This script consisted of 18 questions that cover all the proposed processes. Full details of the script are available in [23].

To begin with, the subject of the research work was introduced and the problem inherent to it was explained.

All the interviewees considered the research work as **"Very Relevant"** enumerating the reasons for that classification: The increase in bulk and presence of OTTs in network traffic can be a potential threat to the CSPs business. Since their growing presence, and the corresponding traffic, are not expected to decrease, it is a real and factual problem that has not yet a solution; OTTs services are dictating consumer habits and so, it is inevitable that they should/must be an integral part of CSPs' offerings;

Regarding difficulty in terms of resources and cost/benefit for the integration of an OTT service, the respondents answered that, technically, it would be equivalent to any other integration they already make and that the benefit

would be the differentiation in the portfolio of services offered.

Regarding an implementation of a distribution model together with OTTs that uses streaming mechanisms but ensures quality of service in the Access network, the respondents answered that it would be easier to prioritize the OTT's traffic with whom they had established an agreement and thus guarantee that OTT service quality.

After the initial questions, the process design was presented and discussed through the diagrams and process flows of the Model. In this interview process, an interactive method was used to carry out the models, such that any suggested improvement could be collected in order to tune the models.

8 Conclusion

The main objective of this work, was to develop a technical model to allow service providers of different nature to work together, or, more specifically, to design a model that allows the integration of Over-the-Top (OTT) services on Communication Services Provider (CSP) platforms.

To conduct this research, a Design Science Research (DSR) process was followed, starting with the clear identification of the problem (nonexistence of a joint model with OTTs providers as Partners of CSPs). In order to obtain a model as accurate as possible, several iterations in the design were performed. To demonstrate the feasibility of the developed solution, some case studies were created considering hypothetical scenarios, but close to reality, in order to understand the real application of the designed model. Finally, to evaluate the accuracy of the methodology, interviews with experts in the industry were conducted, as well as a set of surveys with users of this types of services.

From the evaluation results it was possible to conclude that the model meets the requirements and objectives formulated.

8.1 Future Work

Regarding the outcome of this work, there are several research opportunities that can be addressed in future:

- Detail process models at level 3 and 4 of the eTOM framework, covering further areas of relevance in CSP such as operations, strategy and Product;
- Implement the processes into an experimental platform in partnership with an OTT and OSS / BSS solutions supplier.
- Develop an open API in partnership with an OTT and propose the API to the TMForum.

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